

Claims

- [c1] 1. A method of fabricating a gate dielectric layer, comprising:
providing a substrate;
forming a silicon dioxide layer on a top surface of said substrate;
performing a plasma nitridation in a reducing atmosphere to convert said silicon dioxide layer into a silicon oxynitride layer.
- [c2] 2. The method of claim 1, wherein the step of performing a plasma nitridation is performed using a remote plasma nitridation process.
- [c3] 3. The method of claim 1, wherein the step of performing a plasma nitridation is performed using a nitrogen and an inert gas plasma introduced through a first inlet of a remote plasma nitridation tool and a neutral reducing gas introduced through a second inlet of said remote plasma nitridation tool.
- [c4] 4. The method of claim 3, wherein said inert gas is helium and said reducing gas is hydrogen, ammonia, a mixture of hydrogen and nitrogen, a mixture of ammo-

nia and nitrogen and a mixture of hydrogen, ammonia and nitrogen, deuterium, deuterated ammonia, a mixture of deuterium and nitrogen, a mixture of deuterated ammonia and nitrogen, a mixture of deuterium, deuterated ammonia and nitrogen, or a mixture of deuterium, ammonia and nitrogen.

- [c5] 5. The method of claim 1, wherein the step of performing a plasma nitridation is performed using plasma comprising nitrogen, an inert gas and a reducing gas.
- [c6] 6. The method of claim 5, wherein said inert gas is helium and said reducing gas is hydrogen.
- [c7] 7. The method of claim 1, wherein said substrate includes a bulk silicon or silicon on an insulator substrate and said forming a silicon dioxide layer is formed by a process selected from the group consisting of native oxide growth in air or oxygen, thermal oxidation, rapid thermal oxidation, chemical vapor deposition and oxidizing cleaning processes.
- [c8] 8. The method of claim 1, wherein said silicon dioxide layer has a thickness of about 8 to 23 Å.
- [c9] 9. The method of claim 1, wherein said silicon oxynitride has a thickness of about 8 to 24 Å.

- [c10] 10. The method of claim 1, wherein said silicon oxynitride film contains between about 2 and 20 percent nitrogen.
- [c11] 11. The method of claim 1, wherein the concentration of nitrogen in said silicon oxynitride layer is between about $1\text{E}21$ and $1\text{E}22$ atm/cm^3 .
- [c12] 12. The method of claim 1, wherein the step of performing a plasma nitridation imparts a dose of nitrogen in between about $1\text{E}14$ and $5\text{E}14$ atm/cm^2 to said silicon dioxide layer.
- [c13] 13. The method of claim 1, wherein said silicon oxynitride layer has a thickness of about 0 to 35% greater than the thickness of said silicon dioxide layer.
- [c14] 14. The method of claim 1, wherein the mean thickness of said silicon oxynitride layer varies by no more than about one-half angstrom sigma from a center to an edge of said substrate.
- [c15] 15. The method of claim 1, wherein the nitrogen concentration of said silicon oxynitride layer varies by not more than about 25% from a center to an edge of said substrate.
- [c16] 16. A method of fabricating a MOSFET, comprising:

providing a semiconductor substrate having at least a uppermost silicon layer;
forming a silicon dioxide layer on a top surface of said semiconductor substrate;
performing a plasma nitridation in a reducing atmosphere to convert said silicon dioxide layer into a silicon oxynitride layer;
forming a polysilicon gate on said silicon oxynitride layer aligned over a channel region in said semiconductor substrate; and
forming source/drain regions in said semiconductor substrate, said source drain regions aligned to said polysilicon gate.

- [c17] 17. The method of claim 16, wherein the step of performing a plasma nitridation is performed using a remote plasma nitridation process.
- [c18] 18. The method of claim 16, wherein the step of performing a plasma nitridation is performed using a nitrogen and an inert gas plasma introduced through a first inlet of a remote plasma nitridation tool and a neutral reducing gas introduced through a second inlet of said remote plasma nitridation tool.
- [c19] 19. The method of claim 18, wherein said inert gas is helium and said reducing gas is hydrogen, ammonia, a

mixture of hydrogen and nitrogen, a mixture of ammonia and nitrogen and a mixture of hydrogen, ammonia and nitrogen, deuterium, deuterated ammonia, a mixture of deuterium and nitrogen, a mixture of deuterated ammonia and nitrogen, a mixture of deuterium, deuterated ammonia and nitrogen, and a mixture of deuterium, ammonia and nitrogen.

- [c20] 20. The method of claim 16, wherein the step of performing a plasma nitridation is performed using plasma comprising nitrogen, an inert gas and a reducing gas.
- [c21] 21. The method of claim 20, wherein said inert gas is helium and said reducing gas is hydrogen.
- [c22] 22. The method of claim 16, wherein said substrate includes a bulk silicon or silicon on a insulator substrate and said forming a silicon dioxide layer is formed by a process selected from the group consisting of native oxide growth in air or oxygen, thermal oxidation, rapid thermal oxidation, chemical vapor deposition and oxidizing cleaning processes.
- [c23] 23. The method of claim 16, wherein said silicon dioxide layer has a thickness of about 8 to 23 Å.
- [c24] 24. The method of claim 16, wherein said silicon oxynitride has a thickness of about 8 to 24 Å.

- [c25] 25. The method of claim 16, wherein said silicon oxynitride film contains between about 2 and 20 percent nitrogen.
- [c26] 26. The method of claim 16, wherein the concentration of nitrogen in said silicon oxynitride layer is between about $1\text{E}21$ and $1\text{E}22$ atm/cm^3 .
- [c27] 27. The method of claim 16, wherein the step of performing a plasma nitridation imparts a dose of nitrogen in between about $1\text{E}14$ and $5\text{E}14$ atm/cm^2 to said silicon dioxide layer.
- [c28] 28. The method of claim 16, wherein said silicon oxynitride layer has a thickness of about 0 to 35% greater than the thickness of said silicon dioxide layer.
- [c29] 29. The method of claim 16, wherein the mean thickness of said silicon oxynitride layer varies by no more than about one-half angstrom sigma from a center to an edge of said substrate.
- [c30] 30. The method of claim 16, wherein the nitrogen concentration of said silicon oxynitride layer varies by not more than about 25% from a center to an edge of said substrate.